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Applicants : Swarn S. Kalsi, *et al.*
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Title : THERMALLY-CONDUCTIVE STATOR SUPPORT STRUCTURE

Art Unit : 2834
Examiner : Karl I.E. Tamai

MAIL STOP APPEAL BRIEF – PATENTS

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SWARN S. KALSI AND PETER M. WINN

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(i.) Real Party In Interest

The real party in interest in the above application is American Superconductor Corporation.

(ii.) Related Appeals and Interferences

The appellant is not aware of any appeals or interferences related to the above-identified patent application.

(iii.) Status of Claims

This is an appeal from the decision of the Primary Examiner in an Office Action dated July 20, 2005, rejecting claims 1-19 and 30-36, all of the claims of the above application. Claims 20-29, and 37-41 were canceled. The claims have been twice rejected. Claims 1-19 and 30-36 are the subject of this appeal.

(iv.) Status of Amendments

All amendments have been entered. Appellant has filed herewith a Notice of Appeal on **December 5, 2005**.

(v.) Summary of Claimed Subject Matter

Background

The claimed invention relates to rotating machines, such as superconducting rotor assemblies. [Title, and specification page 1, line 2]

Stator assemblies, like rotor assemblies, generate a considerable amount of heat that must be removed in order for the superconducting machine to operate efficiently. In conventional "non-superconducting" rotating machines, iron teeth are utilized between the individual stator coil assemblies, which act as heat sinks and remove the heat generated by the stator assembly. However, in superconducting machines, the flux density is so great between these stator coil assemblies that these iron teeth would immediately become saturated, resulting in Eddy current heating and operating inefficiency. [Specification, page 2, lines 16-23]

Claim 1

The inventive features of Appellant's claim 1 include a plurality of stator coil assemblies. Appellant's FIG. 11 shows a cross-sectional end view of the stator assembly 512. [FIG. 11].



Another inventive feature of Appellant's claim 1 includes a stator coil support structure, substantially the entire stator coil support structure constructed of a non-magnetic, thermally conductive material. FIG. 11, above, shows the stator support structure 600. [FIG. 11, and

Specification, page 17, line 2]. “[S]tator coil support structure 600 is constructed of a non-magnetic thermally-conductive material, such as: a polymer-based adhesive (e.g., Advanced Thermal Transfer Adhesive, available from the BTech Corporation, 120 Jones parkway, Brentwood, TN 37027); or a graphite-based material (e.g., Grafoil, available from Union Carbide, 39 Old Ridgebury Road, Danbury, CT 06817).” [Specification, page 17, lines 20-24] The stator coil support structure includes the teeth-shaped structure, and the ring surrounding the teeth-shaped structures. [FIG. 11]

In another inventive feature of the Appellant's claim 1, the stator coil support structure includes a plurality of channels, each said channel being configured to receive one or more of said stator coil assemblies, said stator coil support defining an axial passage, about which said plurality of channels are radially positioned, for receiving a rotor assembly and configured to transfer heat from the stator coil assemblies. As shown in FIG. 11, and as described in the Specification, “Stator coil support structure 600 includes an axial passage 602 for receiving rotor assembly 516. Channels 604_{1-n} are positioned radially about the stator coil support structure 600, thus forming teeth 605_{1-n} that act as heat sinking members and absorb the thermal energy generated by the stator coil assemblies 514_{1-n}. These channels are designed and sized to each receive one or more of the stator coil assemblies 514_{1-n}.” [FIG. 11, Specification, page 18, lines 8-12]

Claim 9

Claim 9 recites another aspect of the invention. Claim 9 is a superconducting rotating machine. FIG. 10 shows a superconducting rotating machine. “There is shown in FIG. 10, an alternative embodiment of superconducting rotating machine 510, ...” [FIG. 10, Specification, Page 13, lines 17-18]

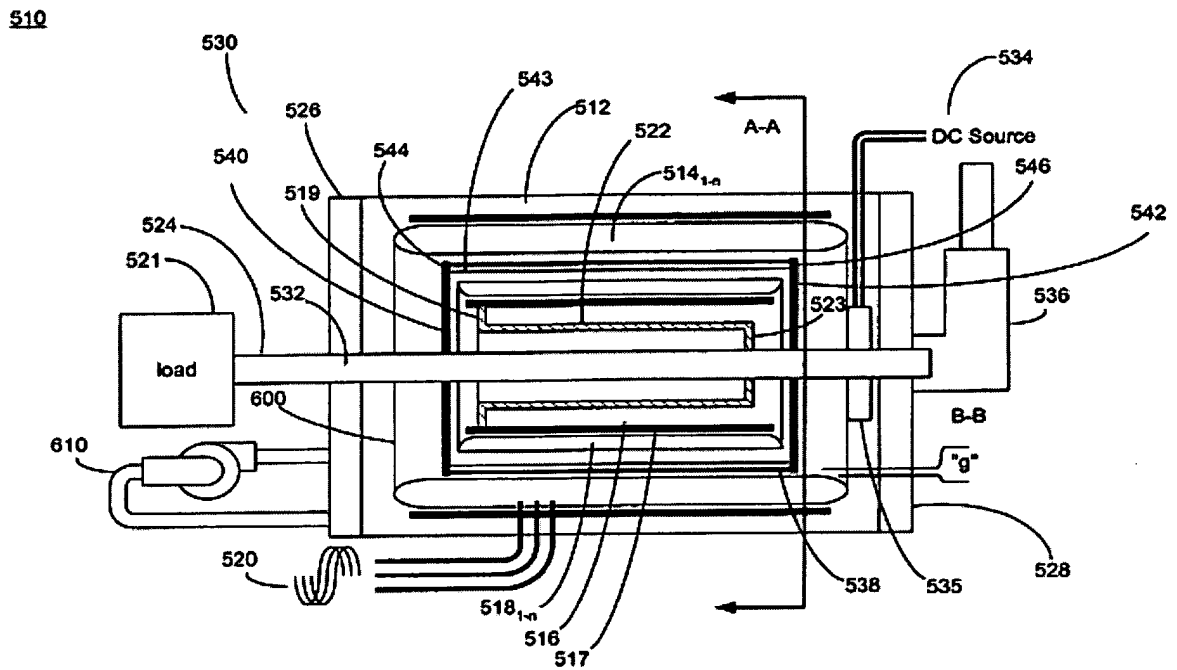


Fig. 10

Inventive features of Appellant's claim 9 include a stator assembly including a plurality of stator coil assemblies. "There is shown in FIG. 10, an alternative embodiment of superconducting rotating machine 510, which includes stator assembly 512 having stator coil assemblies 514_{1-n}." [Specification, page 13, lines 17-18] "FIG. 11 shows the details of a particular embodiment of stator assembly 512. Referring to FIGs. 10 and 11, stator assembly 512 includes a stator coil support structure 600 for supporting and positioning the stator coil assemblies 514_{1-n}." [Specification, page 17, lines 1-3].

Another inventive feature of Appellant's claim 9 include a stator coil support structure, substantially the entire stator coil support structure constructed of a non-magnetic, thermally-conductive material. "Referring to FIGs. 10 and 11, stator assembly 512 includes a stator coil support structure 600." [Specification, page 17, lines 1-2] "[S]tator coil support structure 600 is constructed of a non-magnetic thermally-conductive material, such as: a polymer-based adhesive (e.g., Advanced Thermal Transfer Adhesive, available from the BTech Corporation, 120 Jones parkway, Brentwood, TN 37027); or a graphite-based material (e.g., Grafoil, available from

Union Carbide, 39 Old Ridgebury Road, Danbury, CT 06817).” [Specification, page 17, lines 20-24] The stator coil support structure includes the teeth-shaped structures (teeth 605_{1-n}), and the ring surrounding the teeth-shaped structures. [FIG. 11]

In another inventive feature of the Appellant's claim 9, the stator coil support structure includes a plurality of channels, each said channel being configured to receive one or more of said stator coil assemblies, said stator coil support defining an axial passage, about which said plurality of channels are radially positioned, and configured to transfer heat from the stator coil assemblies. As shown in FIG. 11, and as described in the Specification, “Stator coil support structure 600 includes an axial passage 602 for receiving rotor assembly 516. Channels 604_{1-n} are positioned radially about the stator coil support structure 600, thus forming teeth 605_{1-n} that act as heat sinking members and absorb the thermal energy generated by the stator coil assemblies 514_{1-n}. These channels are designed and sized to each receive one or more of the stator coil assemblies 514_{1-n}.” [FIG. 11, Specification, page 18, lines 8-12]

A further inventive feature of Appellant's claim 9 includes a rotor assembly disposed within the axial passage and configured to rotate within said stator assembly, said rotor assembly including an axial shaft, and at least one superconducting rotor winding assembly. “A rotor assembly 516 rotates within stator assembly 512. As with stator assembly 512, rotor assembly 516 includes rotor winding assemblies 518_{1-n}. In the same 33,000 horsepower superconducting machine design, rotor assembly 516 includes twelve rotor winding assemblies 518_{1-n}. These rotor winding assemblies, during operation, generate a magnetic flux that links rotor assembly 516 and stator assembly 512.” [Specification, page 13, lines 26-30] FIGS. 10 and 11 show shaft 524 positioned in the center of the rotor assembly 516. “Output shaft 524 is supported by a pair of bearing plates 526, 528, one at each end of rotor assembly 516. The bearing plate 526 on the drive end 530 of superconducting rotating machine 510 contains a passage 532 through which output shaft 524 passes.” [Specification, page 14, lines 13-15]

Claim 30

Claim 30 recites another aspect of the invention. Claim 30 is a stator assembly. "FIG. 11 shows the details of a particular embodiment of stator assembly 512" [Specification, Page 17, line 1]

An inventive feature of Appellant's claim 30 includes a plurality of stator coil assemblies. "The stator assembly 512 includes a stator coil support structure 600 for supporting and positioning the stator coil assemblies 514_{1-n}." [FIG. 11, Specification, page 17, lines 2-3].

Another inventive feature of Appellant's claim 30 includes a magnetic annular assembly. "Stator coil support structure 600 is typically surrounded by an outer annular assembly 501 [*sic* – should be 601]. This assembly 601, which is typically constructed of laminated sheet steel, is commonly referred to as the 'back iron' and provides a flux return path for rotor assembly 516." [Specification, page 18, lines 24-27] Also, "[a]ccording to a further aspect of this invention, a stator assembly includes a plurality of stator coil assemblies, a magnetic annular assembly, and a plurality of non-magnetic, thermally-conductive heat sinking members positioned radially about the magnetic annular assembly." [Specification, page 5, lines 4-7]

A further inventive feature of Appellant's claim 30 includes a stator coil support structure, the magnetic annular assembly surrounding the stator coil support structure. "Stator coil support structure 600 is typically surrounded by an outer annular assembly 501 [*sic* – should be 601]." [FIG. 11, Specification page 18, lines 24-25]

In another inventive feature of Appellant's claim 30, the stator coil support structure includes a non-magnetic, thermally-conductive ring section, and a plurality of non-magnetic, thermally-conductive heat sinking members positioned radially about said ring section, thus forming a plurality of channels, each being configured to receive one or more of said stator coil assemblies. "Stator coil support structure 600 includes an axial passage 602 for receiving rotor assembly 516. Channels 604_{1-n} are positioned radially about the stator coil support structure 600, thus forming teeth 605_{1-n} that act as heat sinking members and absorb the thermal energy generated by the stator coil assemblies 514_{1-n}. These channels are designed and sized to each receive one or more of the stator coil assemblies 514_{1-n}." [FIG. 11, Specification, page 18, lines 8-12] "[S]tator coil support structure 600 is constructed of a non-magnetic thermally-conductive material, such as: a polymer-based adhesive (e.g., Advanced Thermal Transfer

Adhesive, available from the BTech Corporation, 120 Jones parkway, Brentwood, TN 37027); or a graphite-based material (e.g., Grafoil, available from Union Carbide, 39 Old Ridgebury Road, Danbury, CT 06817)." [Specification, page 17, lines 20-24] As further shown in FIG. 11, the stator coil support structure 600 includes a ring surrounding the teeth 605_{1-n}. [FIG. 11]

(vi.) Ground of Rejection to be Reviewed on Appeal

Claims 1, 2, 5, 30 and 33 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 4,356,419 to Boer et al. (hereinafter Boer) in view of U.S. Patent 4,330,726 to Albright et al. (hereinafter Albright).

Claims 3, 4, 31 and 32 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Boer and Albright, in further view of U.S. Patent No. 4,709,180 to Denk.

Claims 7, 8, 35 and 36 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Boer and Albright, in further view of U.S. Patent No. 4,385,248 to Laskaris (hereinafter Laskaris).

Claims 6 and 34 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Boer, Albright and Laskaris, in further view of U.S. Patent No. 5,863,467 to Mariner et al. (hereinafter Mariner).

Claims 9, 10, 13 and 19 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Boer and Albright, in further in view of U.S. Patent No. 4,123,676 to Cooper et al. (hereinafter Cooper).

Claims 11 and 12 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Boer, Albright and Cooper, in further view of Denk.

Claims 15 and 16 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Boer, Albright and Cooper, in further view of Laskaris.

Claim 14 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Boer, Albright, Cooper and Laskaris, in further view of Mariner.

Claims 17 and 18 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Boer, Albright, Cooper, in further view of U.S. Patent No. 5,777,420 to Gamble et al.

(vii.) Argument

The Law – Obviousness

“To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations.” (MPEP 2143)

“If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).”

“If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).”

“It is well established that the burden is on the PTO to establish a prima facie showing of obviousness, *In re Fritsch*, 972 F.2d 1260, 23 U.S.P.Q.2d 1780 (C.C.P.A., 1972).”

“It is well established that there must be some logical reason apparent from the evidence or record to justify combination or modification of references. *In re Regal*, 526 F.2d 1399 188, U.S.P.Q.2d 136 (C.C.P.A. 1975). In addition, even if all of the elements of claims are disclosed in various prior art references, the claimed invention taken as a whole cannot be said to be obvious without some reason given in the prior art why one of ordinary skill in the art would have been prompted to combine the teachings of the references to arrive at the claimed invention. *Id.* Even if the cited references show the various elements suggested by the Examiner in order to support a conclusion that it would have been obvious to combine the cited references, the references must either expressly or impliedly suggest the claimed combination or the Examiner must present a convincing line of reasoning as to why one skilled in the art would have found the claimed invention obvious in light of the teachings of the references. *Ex Parte Clapp*, 227 U.S.P.Q.2d 972, 973 (Board. Pat. App. & Inf. 985).”

"The mere fact that the prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification." *In re Gordon*, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984).

Although the Commissioner suggests that [the structure in the primary prior art reference] could readily be modified to form the [claimed] structure, "[t]he mere fact that the prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification." *In re Laskowski*, 10 U.S.P.Q. 2d 1397, 1398 (Fed. Cir. 1989).

"The claimed invention must be considered as a whole, and the question is whether there is something in the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination." *Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick*, 221 U.S.P.Q. 481, 488 (Fed. Cir. 1984).

Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination. Under Section 103, teachings of references can be combined only if there is some suggestion or incentive to do so. *ACS Hospital Systems, Inc. v. Montefiore Hospital*, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984) (emphasis in original, footnotes omitted).

"The critical inquiry is whether 'there is something in the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination.'" *Fromson v. Advance Offset Plate, Inc.*, 225 U.S.P.Q. 26, 31 (Fed. Cir. 1985).

(1) The examiner has failed to establish a prima facie case of obviousness for combining the references.

Claims 1

For the purposes of this appeal only, claims 1-6, 9-14, 17-19, and 30-34 may be treated as standing or falling together. Claim 1 is representative of this group.

Claim 1 is directed to a stator assembly having a stator coil support structure that is substantially constructed of a non-magnetic, thermally conductive material. As described in the Specification:

Further, it is undesirable to use a magnetically-saturatable stator coil support structure, as this results in the generation of hysteresis and eddy current losses, thus lowering the efficiency of the superconducting rotating machine 510 by heating the stator coil assembly. Accordingly, stator coil support structure 600 is constructed of a non-magnetic thermally-conductive material ...

By using a non-magnetic, thermally-conductive material, stator heating resulting from the presence of eddy currents is eliminated. Further, any heat generated by stator coil assemblies 5141-n can be easily removed ... (Specification, page 17, line 17 to page 18, line 3)

The examiner admits that “Boer teaches the coil support (teeth) being non-magnetic and thermally conductive but not then entire coil support being non-magnetic and thermally conductive material” (Office Action page 2, paragraph 3). The examiner, however, contends that “Albright teaches the entire coils support being non-magnetic. ... It would have been obvious to a person of ordinary skill in the art at the time of the invention to construct the machine of Boer with the non-magnetic coil support section 2 entirely supporting the coil as in Albright to properly support and coil the motor ...” (Office Action, page 2, paragraph 3)

Appellant's respectfully submits that the Examiner failed to: (a) recite all features of Appellant's claim 1, and (b) provide a motivation for combining Boer and Albright.

The Prior Art References Fail to Teach all the Claimed Limitations

Boer describes an apparatus for fastening an air gap winding for electric machines having a large power rating (Abstract). Boer's apparatus includes a lamination stack 20 that comprises

tooth-shaped segment parts 202 formed from non-magnetic material, and segment parts 201, without teeth, formed from a magnetic material (Boer's FIG. 2, col. 2, lines 5-8, and col. 4, lines 21-32).

Albright describes a stator that comprises a stack of modular sections, each comprising an outer cylinder and an inner cylinder. As shown in Albright's FIG. 1, Albright's inner cylinder 14 includes teeth portions and a surrounding ring. Albright states that the inner cylinder 14 is constructed from a non-metallic material, and explains, "[T]he inner cylinder 14 preferably comprises laminations of a material such as glass fiber impregnated with melamine or epoxy resin" (Albright, col. 4, lines 24-27).

Appellant's explains in its Specification:

stator coil support structure 600 is constructed of a non-magnetic thermally-conductive material, such as: a polymer-based adhesive (e.g., Advanced Thermal Transfer Adhesive, available from the BTech Corporation, 120 Jones parkway, Brentwood, TN 37027); or a graphite-based material (e.g., Grafoil, available from Union Carbide, 39 Old Ridgebury Road, Danbury, CT 06817). These materials have a favorable thermal transfer coefficient of at least 100 Watt / Meter Kelvin. Specifically, Advanced Thermal Transfer Adhesive has a thermal transfer coefficient of between 100 and 450 Watt / Meter Kelvin and Grafoil has a thermal transfer coefficient of between 140 and 375 Watt / Meter Kelvin. By comparison, glass epoxy material has a thermal transfer coefficient of ~ 0.60 Watt / Meter Kelvin. (emphasis added, specification, Page 17, lines 20-29)

Thus, glass epoxy materials are specifically identified by Appellant as thermally non-conductive. Accordingly, Albright's glass fiber material used for constructing the inner cylinder 14 is not thermally conductive. Moreover, it is not clear from Albright whether the material used for constructing the inner cylinder 14 is even non-magnetic. All Albright says is that the material is "non-metallic"

Accordingly, combining Boer's non-magnetic tooth-shaped segment parts 202 with Albright's non-magnetic and thermally non-conductive material fails to describe "a stator coil support structure, substantially the entire stator coil support structure constructed of a non-magnetic, thermally-conductive material," as required by Appellant's claim 1.

Therefore, Appellant respectfully submits that the proposed combination fails to disclose all the elements recited by claim, and thus the Examiner has failed to establish a *prima facie* case of obviousness.

Examiner's Combination of the Prior Art References Amounts to Hindsight Analysis

Appellant submits that in any event the Examiner's proposed combination of Boer and Albright to teach Appellant's recited limitations in claim 1 amounts to an improper hindsight analysis.

In a December 1, 2005, Examiner's Interview in which Appellant's undersigned attorney and the Examiner discussed the Examiner's proposed combination of Boer and Albright, the Examiner stated on the Continuation Sheet of the December 7, 2005, Interview Summary:

Applicant argues the rejection the references cannot be combined and the examiner is picking and choosing features from each of the references. The examiner disagrees. The two references are very analogous art directed to stator cores with both magnetic and non-magnetic portions. Boer specifically teaches the inner portion of the core is non-magnetic sheet metal to form a magnetic shielding section and a non-magnetic holding section. Albright is only combined because the claims were amended to include the entire coil being supported by the non-magnetic support, which is shown by Albright. The references must be taken for the combined teaching not what they teach individually (In re Keller, 642 F.2d 413).

Appellant first notes that the claim 1, as well as independent claims 9 and 30 were amended to recite that "substantially the entire stator coil support structure constructed of a non-magnetic, thermally conductive material", and not merely to recite that the stator coil support structure is constructed from a non-magnetic material. As for the Examiner's comments, the Examiner is selecting isolated properties of elements described in the references, while ignoring other properties of those elements, to teach the Appellant's claimed limitations. Thus, under the Examiner's proposed combination, the non-magnetic nature of the material used for Albright's inner cylinder 14 is combined with Boer's structure, but the non-thermally conductive property of the material is disregarded.

As the Court stated in *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132 (Fed. Cir. 1985), "[i]t is an error to reconstruct the patentee's claimed invention from the prior art by using the patentee's claim as a 'blueprint'. When prior art references require selective combination to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight obtained from the invention itself. It is critical to understand the particular results achieved by the new combination" (emphasis added). Further, in *ADT Corp. v. Lydall, Inc.*, 159

F.3d 534 (Fed. Cir., 1998) the Court stated, “[d]etermination of obviousness can not be based on hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention.”

As explained above, Boer discloses an apparatus having a lamination segment 20 that comprises tooth-shaped segment parts 202 formed from non-magnetic material, and segment parts 201, without teeth, formed from a magnetic material. Boer does not explicitly recite that the non-magnetic material of the tooth-shaped segment parts 202 is also thermally-conductive. Albright, on the other hand, discloses an inner cylinder 14 made entirely of a non-magnetic, but thermally non-conductive material. The Examiner proposes to combine just the feature of the non-magnetic property of the entire inner cylinder 14 with Boer's non-magnetic tooth-shaped parts 202 to achieve a stator coil support structure that is entirely non-magnetic. But neither Boer nor Albright provides a suggestion or motivation for combining these two references in the manner indicated by the Examiner (that is, by using only the non-magnetic aspect of the material of Albright's inner cylinder 14). The only suggestion for the particular combination of Boer and Albright is Appellant's own claim 1 which calls for a stator coil support structure made substantially entirely from a non-magnetic, thermally conductive material.

Accordingly, Appellant's submits that even if, *arguendo*, the combination of Boer and Albright teaches the limitations of Appellant's claim 1, such a combination is an impermissible hindsight combination based on Appellant's design as described in claim 1.

There is No Motivation to Combine The References

Appellant further respectfully contends that there is no motivation to combine the Boer and Albright reference.

As explained above, Boer's lamination segment 20 (which constitutes part of the lamination stack 1) comprises tooth-shaped segment parts 202 formed from non-magnetic material, and segment parts 201, without teeth, formed from a magnetic material (Boer's FIG. 2, col. 2, lines 5-8, and col. 4, lines 21-32). With reference to this specific construction, Boer explains:

Through this construction, the stator lamination stack and the mounting body are combined to form a single component, which meets all requirements regarding controlling the tangentially attacking forces and

ensures a short-circuit proof connection of the air gap winding to the shielding package. The lamination segments fabricated by welding from different segment parts have approximately the same mechanical strength as a homogeneous lamination segment and are divided, due to the magnetic properties, into a magnetic shielding zone and a non-magnetic holding zone. (emphasis added, Boer's col. 2, lines 18-28)

Thus, Boer's specific construction requires that there be a magnetic shielding zone (provided through the magnetic segment portions 201) and a non-magnetic shielding zone (provided through the non-magnetic tooth-shaped portions 202).

Albright, on the other hand, describes a stator that comprises a stack of modular sections, each comprising an outer cylinder and an inner cylinder. As shown in Albright's FIG. 1, Albright's inner cylinder 14, which includes teeth portions and a surrounding ring, is constructed from a non-metallic material (Albright, col. 4, lines 25-26). Thus, because Albright's entire inner cylinder 14 is constructed from non-metallic material, Albright's construction cannot form a magnetic shielding zone and a non-magnetic holding zone. Rather, Albright only has a non-magnetic zone (assuming, *arguendo*, that Albright's non-metallic material is non-magnetic).

Accordingly, since Boer calls for a magnetic shielding zone, to modify Boer's teachings to include Albright's non-magnetic inner cylinder 14, which is incapable of creating the magnetic shielding zone required by Boer, would render Boer's apparatus completely unsatisfactory for its intended purpose, and/or change its principle of operation. Accordingly, there can be no suggestion or motivation for combining Boer with Albright.

Since the combination of Boer and Albright fails to disclose at least the limitation of "a stator coil support structure, substantially the entire stator coil support structure constructed of a non-magnetic, thermally-conductive material," and since in any event there is no motivation to combine Boer with Albright, the Examiner has thus failed, with respect to independent claims 1, to establish a *prima facie* case of obviousness for combining Boer and Albright.

With respect to Appellant's claim 9, the Examiner stated "Boer and Albright teach every aspect of the invention except a superconducting rotor. Cooper teaches a refrigerated, superconducting rotor. It would have been obvious to a person of ordinary skill in the art at the

time of the invention to construct the stator of Boer and Albright with the rotor of Cooper to provide a low loss field rotor" (Office Action, page 4, paragraph 7).

For reasons similar to those provided with respect to Appellant's claim 1, the combination of Boer and Albright fails to disclose at least the limitation of "a stator coil support structure, substantially the entire stator coil support structure constructed of a non-magnetic, thermally-conductive material." Furthermore, in any event there is no motivation to combine Boer with Albright to arrive at the feature.

Cooper describes a rotor for an AC current generator carrying a superconducting field winding (Abstract). Cooper describes a stator having an armature winding 14 that is supported by a laminated magnetic shield 16 surrounding the winding and supported in the housing 10. Cooper, therefore, does not disclose or suggest at least the feature of "a stator coil support structure, substantially the entire stator coil support structure constructed of a non-magnetic, thermally-conductive material," as recited by Appellant's claim 9.

The Examiner has thus failed, with respect to independent claims 9, to establish a *prima facie* case of obviousness for combining Boer, Albright and Cooper.

Claims 7, 15 and 35

For the purpose of this appeal only, claims 7, 15 and 35 may be treated as standing or falling together. Claim 7 is representative of this group

Claim 7 adds the distinct feature that the non-magnetic, thermally conductive material is a graphite based laminated sheet materials. The Examiner admits that "Boer and Albright teach every aspect of the invention except, the wedge material 2 being graphite based ..." (Page 3, paragraph 5 of the Office Action). The Examiner, however, contends that U.S. Patent No. 4,385,248 to Laskaris teaches this feature, and states, "Boer [*sic* – should read Laskaris] teaches the wedges are epoxy-graphite".

Laskaris describes a method and structure for restricting relative sliding motion at the interface between a superconducting winding and a supporting structure for the winding (Abstract). Laskaris structure includes a semi-cylindrical support structure 11 comprising an

outer cylindrical shell 16 and an inner complementary shaped semi-cylindrical shell 17 (Laskaris, FIG. 2, col. 14, lines 9-12). The inner and outer shells 16 and 17 define an annular space in which nested saddle-shaped windings 12, 12', 13, and 13' are mounted (Laskaris, col. 4, lines 14-17). Thus, Laskaris shell-shaped structure supports superconducting windings. Laskaris structure is not a stator coil support structure.

Laskaris describes several materials that may be used for constructing the shells 16 and 17, including high strength aluminum alloy (col. 5, lines 52-54), titanium alloy (col. 5, lines 66-67), and observes:

In fabricating one embodiment of the invention, the inner and outer frusto-conical shells 17 and 16 were made of a high strength aluminum alloy. ...

In another embodiment of the invention, the inner conical shell 17 was made of a titanium alloy while the outer conical shell 16 was made of a structural aluminum alloy. The pole sections 19 also were made of a titanium alloy while the wedges 21 and 22 were made of an epoxy-glass fiber reinforced composite material. The outer shell 16 was then shrunk fit around the subassembly of the winding-core-wedges-inner shell using a moderate interference fit. In this construction both the inner shell and the winding-core-wedge material combination had a lower coefficient of thermal contraction than the outer shell. By adjusting the thickness of the inner shell to be lower than the thickness of the outer shell, the interference fit between the winding and the structure is increased at low temperatures.

...

It should be noted that the choices of materials used in fabricating the inner and outer shells as well as the core and wedge material constitute only a convenient illustration of two assembly procedures. It is entirely possible that other materials such as nickel-base alloys or fiber reinforced advanced composites such as the Kevlar-epoxy or graphite-epoxy, might be equally good or better choices for actual applications of the invention.

Thus, the choice of materials for Laskaris' inner and outer shells 16 and 17 is based on the strength of the materials and on their thermal contraction properties.

On the other hand, as described in Appellant's Specification:

Accordingly, stator coil support structure 600 is constructed of a non-magnetic thermally-conductive material, such as: a polymer-based adhesive (e.g., Advanced Thermal Transfer Adhesive, available from the BTECH Corporation, 120 Jones parkway, Brentwood, TN 37027); or a graphite-based material (e.g., Grafoil, available from Union Carbide, 39 Old Ridgebury Road, Danbury, CT 06817).

Thus, Appellant's choice of graphite based materials for constructing the Appellant's stator coil support structure is the materials' non-magnetic, thermally conductive properties.

Neither Boer nor Albright provide any suggestion and/or motivation for combining those references with Laskaris' teaching of a graphite material having suitable strength and thermal contraction properties that is used for constructing a superconducting winding shell-shaped support structure. Contrary to the Examiner's position, a person of ordinary skill in the art would not turn to Laskaris for its teaching regarding the graphite-epoxy materials since Laskaris is not directed to stator coil support structure, and Laskaris does not deal with the problem of excessive heat removal.

Appellant therefore submits that a *prima facie* case of obviousness in relation to claim 7 has not been met.

Claim 8, 16 and 36

For the purpose of this appeal only, claims 8, 16 and 36 may be treated as standing or falling together. Claim 8 is representative of this group.

Claim 8 adds the distinct feature that an epoxy filler is disposed between the stator coil assemblies and the stator coil support structure. As explained in the Specification, "[s]ince air is a relatively poor conductor of heat, an epoxy filler 612 (e.g., a low viscosity liquid resin) is utilized to fill any voids between stator coil assemblies 514_{1-n} and channels 604_{1-n}. This epoxy filler 612 can be either drawn into these voids through the use of a vacuum or pushed into the voids using positive pressure" (Specification, page 19, lines 5-8). The examiner contends that "Boer teaches the wedges are epoxy-graphite, which would have inherently include epoxy between the coils and the support" (Office Action, page 3, paragraph 5). Boer describes at col. 3, lines 44-52:

Between the radially outer end faces of the winding bars 3, 4 and 5 and the slot bottom formed by the inner edge of the stator lamination stack 1, an insulating insert 6 of insulating material is disposed. Meanwhile insulating material inserts 7 are inserted into the spaces between the winding bars 3 and 4, and 4 and 5, respectively. To obtain even better tangential tightening,

the insulating material inserts 7 may also have the form of corrugated springs.

Thus, Boer does not disclose an epoxy-filler disposed between the stator coil assemblies and the support structure, which can be used to conduct heat, but rather discloses the use of an insulating material that is intended to provide tangential tightening between the winding bars and the slot bottom of Boer's lamination stack. Boer also does not disclose that the winding bars are themselves epoxy impregnated. Accordingly, contrary to the Examiner's contention, Boer does not describe or suggest the use of epoxy fillers.

If the Examiner meant to rely on Laskaris to show this inventive feature of Appellant's claim 8, the Appellant respectfully submits under those circumstances Laskaris also does not show this feature. Laskaris describes at FIG. 3, and at col. 3, line 53, to col. 4, line 9:

FIG. 3 is a cross-sectional view of one of the winding modules 12 or 13 and illustrates its construction. As shown in FIG. 3, each of the winding modules is comprised of a plurality of conductors, such as shown at 14, which are bunched together in close thermal and electrical contact with one another in a solid winding bundle which then is treated with epoxy resin so that all of the individual conductors 14 are epoxyed together. In the embodiment of the invention herein illustrated, the conductors 14 are fabricated from a superconducting material. While winding the individual superconducting conductors 14 together in a bunch, the winding process takes place on a suitable mandrel so that the saddle-shaped configuration illustrated in FIG. 4 is achieved.

After formation of the saddle-shaped winding modules 12 and 13, and the corresponding lower set of modules 12' and 13' (not shown) in the above-described manner, each of the modules is wrapped or otherwise enclosed in a suitable interface lining material shown at 15 in FIG. 3. The interface lining material 15 is electrically insulating in nature and has a low shear modulus of elasticity. Suitable materials for use as the interface lining material are leather, cellulose paper, polyethylene paper and like materials.

The Examiner's characterization of Laskaris (assuming the Examiner intended to rely on Laskaris) is incorrect. Although Laskaris discloses that the conductors 14 of the winding modules 12 and 13 are impregnated with epoxy, there is no epoxy disposed between the treated conductors and the support structure. Appellant's inventive feature requires that the epoxy filler be disposed between the coils and the support structure. This limitation is not met by the conductors being impregnated with epoxy because the area between the conductors and Laskaris support structure does not have the epoxy material. Rather, Laskaris explicitly provides that the area between the conductors of the winding modules and the support structure is filled with an

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insulating interface lining material and not conductive epoxy material, as required by Appellant's claim 8. Accordingly, Boer does not disclose or suggest "The stator assembly of claim 1 further comprising an epoxy filler disposed between said stator coil assemblies and said stator coil support structure," recited by claim 8.

Conclusion

Appellant submits, therefore, that claims 1-19 and 30-36 are allowable over the cited art. Therefore, the Examiner erred in rejecting Appellant's claims and should be reversed.

Respectfully submitted,

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Appendix of Claims

1. A stator assembly comprising:
a plurality of stator coil assemblies; and
a stator coil support structure, substantially the entire stator coil support structure constructed of a non-magnetic, thermally-conductive material, said stator coil support structure including:
a plurality of channels, each said channel being configured to receive one or more of said stator coil assemblies, said stator coil support defining an axial passage, about which said plurality of channels are radially positioned, for receiving a rotor assembly and configured to transfer heat from the stator coil assemblies.
2. The stator assembly of claim 1 wherein each said stator coil assembly is surrounded by a ground plane assembly.
3. The stator assembly of claim 1 further comprising a magnetic annular assembly surrounding said stator coil support structure, wherein said magnetic annular assembly includes a plurality of axial coolant passages.
4. The stator assembly of claim 3 further comprising a coolant circulation system for circulating a cooling liquid through said axial coolant passages.
5. The stator assembly of claim 1 wherein said non-magnetic, thermally conductive material is a sheet material, said sheet material being laminated to form said stator coil support structure.
6. The stator assembly of claim 5 wherein said sheet material is a polymer-based adhesive.
7. The stator assembly of claim 5 wherein said sheet material a graphite-based material.

8. The stator assembly of claim 1 further comprising an epoxy filler disposed between said stator coil assemblies and said stator coil support structure.

9. A superconducting rotating machine comprising:
a stator assembly including a plurality of stator coil assemblies, and a stator coil support structure, substantially the entire stator coil support structure constructed of a non-magnetic, thermally-conductive material, said stator coil support structure including: a plurality of channels, each said channel being configured to receive one or more of said stator coil assemblies, said stator coil support defining an axial passage, about which said plurality of channels are radially positioned, and configured to transfer heat from the stator coil assemblies; and

a rotor assembly disposed within the axial passage and configured to rotate within said stator assembly, said rotor assembly including an axial shaft, and at least one superconducting rotor winding assembly.

10. The superconducting rotating machine of claim 9 wherein each said stator coil assembly is surrounded by a ground plane assembly.

11. The superconducting rotating machine of claim 9 wherein said stator assembly further includes a magnetic annular assembly surrounding said stator coil support structure, wherein said magnetic annular assembly includes a plurality of axial coolant passages.

12. The superconducting rotating machine of claim 11 further comprising a coolant circulation system for circulating a cooling liquid through said axial coolant passages.

13. The superconducting rotating machine of claim 9 wherein said non-magnetic, thermally conductive material is a sheet material, said sheet material being laminated to form said stator coil support structure.

14. The superconducting rotating machine of claim 13 wherein said sheet material is a polymer-based adhesive.

15. The superconducting rotating machine of claim 13 wherein said sheet material is a graphite-based material.

16. The superconducting rotating machine of claim 9 further comprising an epoxy filler disposed between said stator coil assemblies and said stator coil support structure.

17. The superconducting rotating machine of claim 9 wherein said at least one superconducting rotor winding assembly is constructed using a high-temperature, superconducting material.

18. The superconducting rotating machine of claim 17 wherein said high temperature, superconducting material is chosen from the group consisting of: thallium-barium-calcium-copper-oxide; bismuth-strontium-calcium-copper-oxide; mercury-barium-calcium-copper-oxide; and yttrium-barium-copper-oxide.

19. The superconducting rotating machine of claim 9 further comprising a refrigeration system for cooling said at least one superconducting rotor winding assembly.

20-29. (Cancelled).

30. A stator assembly comprising:
a plurality of stator coil assemblies; a magnetic annular assembly; and
a stator coil support structure, the magnetic annular assembly surrounding the stator coil support structure, the stator coil support structure including:
a non-magnetic, thermally-conductive ring section; and
a plurality of non-magnetic, thermally-conductive heat sinking members
positioned radially about said ring section, thus forming a plurality of channels, each being

configured to receive one or more of said stator coil assemblies, said plurality of non-magnetic, thermally-conductive heat sinking members, in aggregate, defining an axial passage for receiving a rotor assembly and configured to transfer heat from the stator coil assemblies.

31. The stator assembly of claim 30 wherein said magnetic annular assembly includes a plurality of axial coolant passages.

32. The stator assembly of claim 31 further comprising a coolant circulation system for circulating a cooling liquid through said axial coolant passages.

33. The stator assembly of claim 30 wherein said non-magnetic, thermally-conductive heat sinking members are constructed of a non-magnetic, thermally conductive sheet material, wherein said sheet material is laminated to form said non-magnetic, thermally-conductive heat sinking members.

34. The stator assembly of claim 33 wherein said sheet material is a polymer-based adhesive.

35. The stator assembly of claim 33 wherein said sheet material a graphite-based material.

36. The stator assembly of claim 30 further comprising an epoxy filler disposed between said stator coil assemblies and said non-magnetic, thermally-conductive heat sinking members.

37-41. (Cancelled).

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EVIDENCE
APPENDIX

None

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RELATED PROCEEDINGS

APPENDIX

None